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(54) Solid propellant rocket motor

(57) A coiled strip solid propellant 16 forms a scroll in a combustion chamber 12, 14. A perforated shield 16 is disposed between the combustion chamber and a nozzle 20 to prevent any portion of the solid propellant from entering the nozzle during operation.

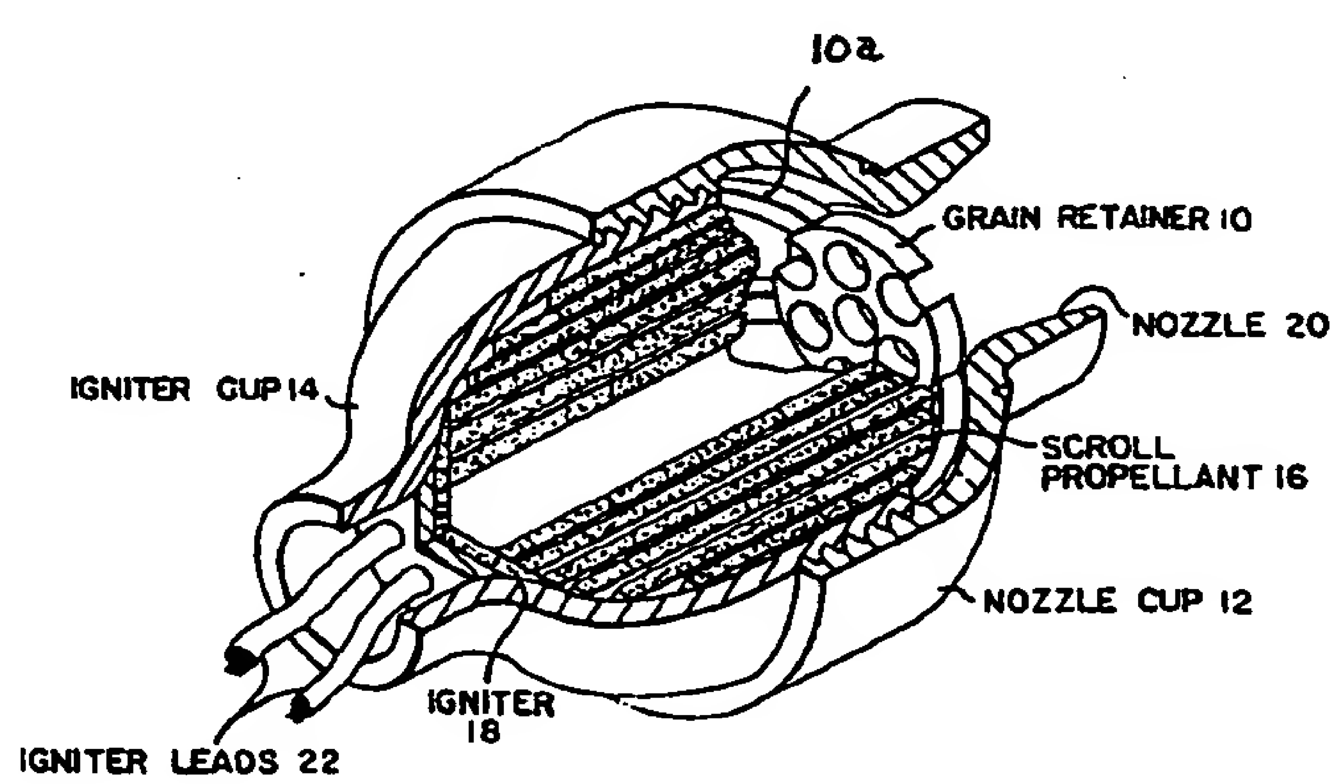

FIG. 1

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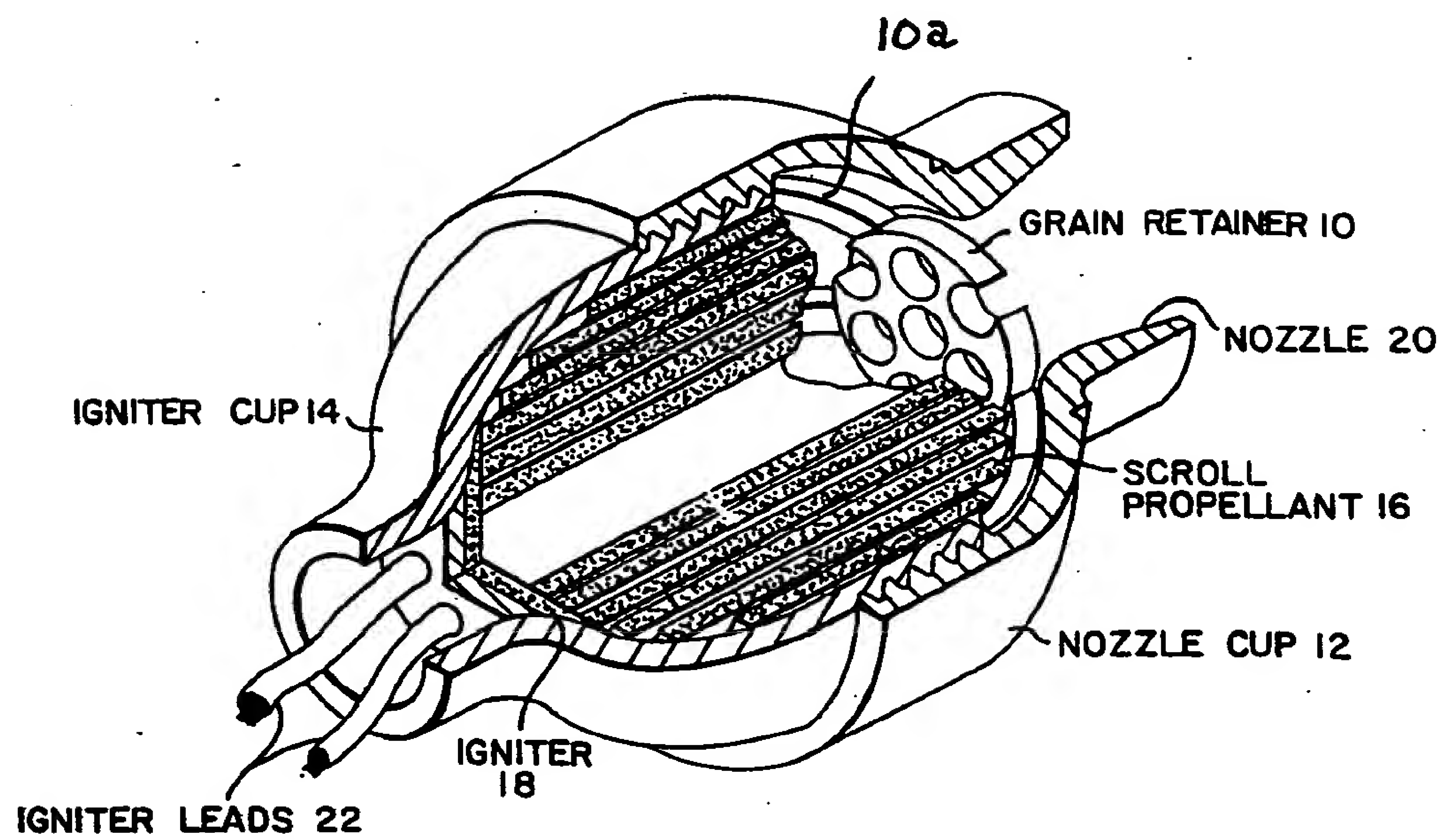

FIG. 1

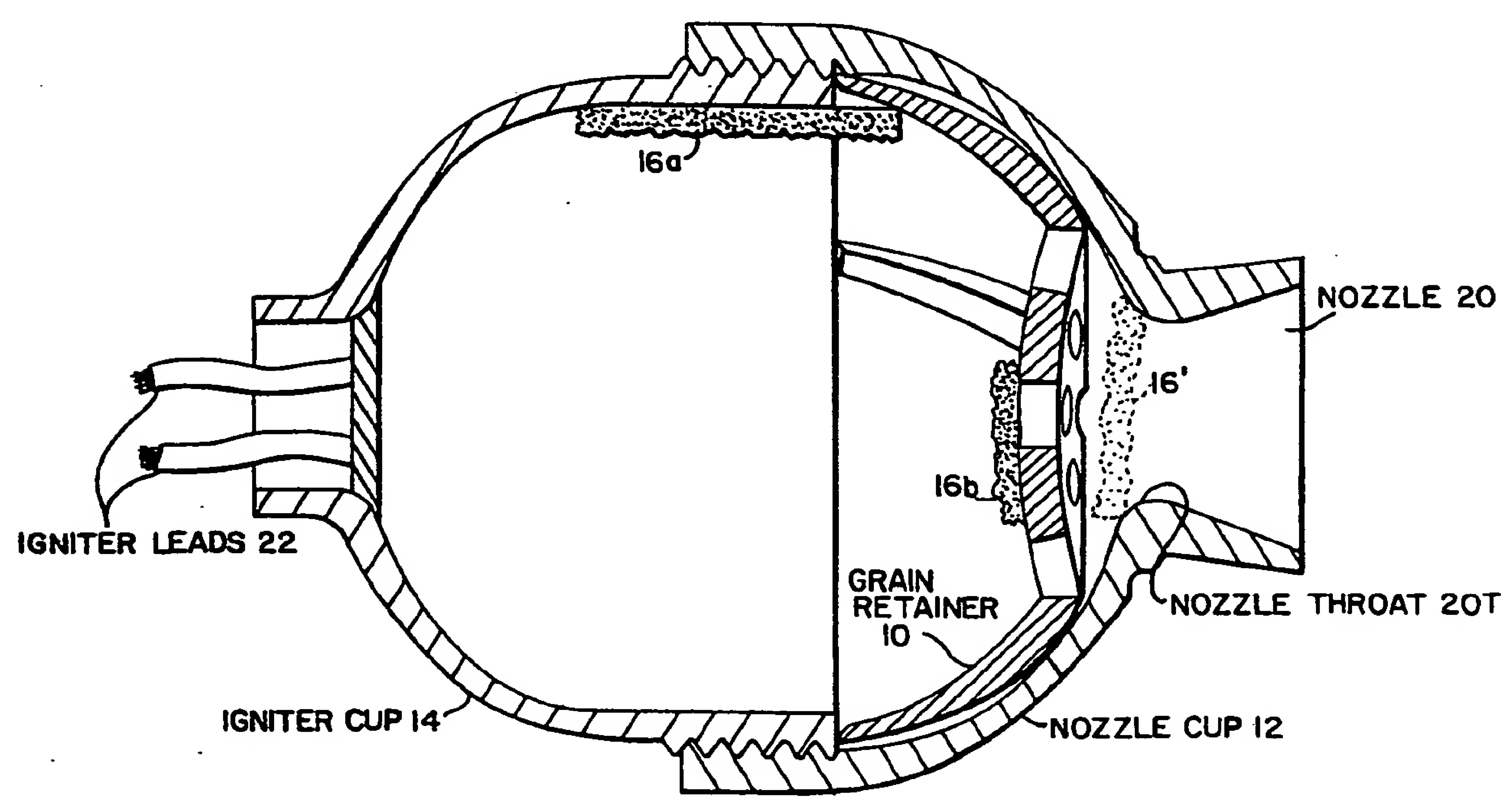

FIG. 2

SPECIFICATION
Solid propellant rocket motor

This invention pertains to rocket motors which use a solid propellant.

It is known that a rocket motor using a solid propellant formed as a scroll is susceptible to failure in operation, especially when the ambient temperature is high. For example, at various times to date during the almost fifteen year life of the DRAGON missile, catastrophic failures have been experienced by reason of such failures in rocket motors used to manoeuvre, the missile during operation.

The object of this invention is to overcome such problems.

According to the present invention, there is provided a rocket motor comprising a combustion chamber a solid propellant disposed, in the form of a coiled strip, within the chamber, a nozzle leading from the chamber to form a jet of combustion gases from burning the propellant, and a perforated shield positioned between the combustion chamber and the nozzle.

The perforated shield can be arranged to prevent any unburned portion of the solid propellant from entering the nozzle while having an insignificant effect on the flow of combustion gases through the nozzle.

The invention will be described in more detail, by way of example, with reference to the accompanying drawings, in which:—

FIGURE 1 is an isometric view, partially cut away, showing a preferred embodiment of a rocket motor according to this invention; and

FIGURE 2 is a longitudinal cross-section of the rocket motor of Figure 1 showing how catastrophic failure is avoided.

The rocket motor includes a conventional arrangement of elements, plus a perforated shield 10 (referred to as the grain retainer). A combustion chamber is made up of a nozzle cup 12 and an igniter cup 14 which screw together and enclose a scroll propellant 16, an igniter 18 and the grain retainer 10. A nozzle 20 is integrally formed with the nozzle cup 12 and igniter leads 22 pass through the igniter 18 to fire the propellant in response to a firing signal.

The scroll propellant 16 is coiled so that, at normal ambient temperatures, the outside of the scroll propellant fits loosely within the combustion chamber. The scroll propellant here is type M-36 double base propellant manufactured by Hercules Radford Arsenal, Radford, Virginia, U.S.A. and is made up of nitro-glycerin nitrocelulose. At high ambient temperatures, i.e. temperatures above 37°C, the scroll propellant 16 expands enough so that its outside fits snugly in the combustion chamber.

The igniter 18 is of the electrical bridgewire type with 7.5 Ω resistance. The explosive prime mix is a lead styphnate-potassium perchlorate mixture, while the secondary mix is a zirconium powder, potassium perchlorate and barium nitrate mixture. The manufacturer is Quantic Products, 990 Commercial Street, San Carolos, California 94070 or Space Ordnance Systems, Militas, California 94131, U.S.A. The igniter is designed for fast and reproducible ignition time.

The grain retainer 10 is fabricated in any conventional manner using a single piece of half hard, stainless steel (e.g. American Standard 305) to provide a perforated shield and a plurality of resilient fingers 10a outwardly extending from points around the periphery of the perforate base. The perforated shield and resilient fingers are so dimensioned that, when installed in the nozzle cup 12, the shield fills the nozzle throat 20T of the nozzle 20 and the fingers prevent movement of the shield during operation. The number and locations of the perforations in the shield may be varied as desired as long as, during operation, flow of combustion gases from the combustion chamber through the nozzle throat 20T and nozzle 20 is not significantly impeded and the structural integrity of the grain retainer 10 is maintained. To increase the strength of the grain retainer 10 it is preferred (as shown more clearly in Figure 2) that it be slightly crowned into the combustion chamber.

Referring now to Figure 2, the reason for catastrophic failure of a conventional rocket motor and the way in which the contemplated arrangement obviates the possibility of such a failure may be seen. Thus, in Figure 2 it may be seen that at high ambient temperatures when combustion of the scroll propellant 16 (Figure 1) is almost complete, a portion 16a of the outer layer of the propellant has been forced initially by the pressure of the combustion gases generated during combustion of the already burned scroll propellant 16 to remain against the inner surface of the combustion chamber. Consequently, curing of the portion 16a can take place only from the surface not in contact with the inner surface of the combustion chamber. Before burning of the portion 16a has been completed, the part 16' still to be burned may be lifted from the inner surface of the combustion chamber by the combustion gases and blown into the nozzle throat 20T to block the flow of combustion gases. Almost instantaneously, then, the pressure of the combustion gases within the combustion chamber builds up to exceed the maximum pressure which can be contained by the igniter cup 14 or the nozzle cup 12. A catastrophic failure then occurs.

With the grain retainer 10 in place, any unburned part 16b of the outer portion, shown in dashed lines of the scroll propellant 16 (Figure 1) which may be separated from the inner wall of the combustion chamber is blown against the shield of the grain retainer 10. Only in the almost impossible case when the unburned portion simultaneously covers every opening in the shield would the flow of combustion gases be blocked; in every other possible case hot combustion gases are present on both sides of the unburned portion with the result that complete combustion occurs without any significant blockage of the flow of combustion gases or any appreciable rise in pressure within the combustion chamber.

CLAIMS

1. A rocket motor comprising a combustion chamber a solid propellant disposed, in the form of a coiled strip, within the chamber, a nozzle leading from the chamber to form a jet of combustion gases from burning the propellant, and a perforated shield position between the combustion chamber and the nozzle.

2. A rocket motor according to claim 1, wherein the material of the shield is steel.

3. A rocket motor according to claim 1 or 2, wherein a plurality of outwardly extending, resilient fingers are formed integrally with, and around the perimeter of, the perforated shield, the fingers being in contact with the inner wall of the combustion chamber adjacent to the nozzle.

4. A rocket motor according to claim 1, 2 or 3, wherein the perforated shield is crowned towards the combustion chamber.

5. A rocket motor substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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